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ADAPTABLE MINIATURE INITIATION SYSTEM TECHNOLOGY (AMIST)

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Adaptable Miniature Initiation System Technology

Researchers develop multipoint initiation technology to tailor weapon effects.

The ever-changing nature of warfare presents constant challenges to weapon system designers, who must carefully consider various perspectives of mutual importance. Specifically, designers must address constraints associated with newly developed aircraft, such as the F-22 andF-35, which carry their stores internally and thus have size limitations on their payloads. Weapons designers must also recognize the weight of political pressures that fuel concerns about a given weapon's potential to cause collateral damage to civilian populations. At the same time, they must respond adequately to warfighter demand for the flexibility to employ the most effective weapon against a given target. These distinct—but inter-related—challenges emphasize the need for smaller, more efficient, and highly accurate weapons with controlled damage effects. Moreover, the availability of highly adaptable munitions that serve multiple functions will provide more options in meeting emergent threats and targets of opportunity on the battlefield. For example, if a small, dual-role warhead could dynamically focus a greater percentage of its total explosive energy towards a target, it would provide acceptable probability-of-kill values while also reducing the potential for collateral damage to the surrounding environment. The dual functionality of this warhead would also provide the warfighter with the real-time flexibility to engage in both counter air and interdiction operations with a single weapon. Development of focused warhead weapons, such as the dual-role munition, requires an interdisciplinary technical solution incorporating aerodynamic, energetic, warhead, target detection, and initiation system technologies. AFRL is collaborating with the US Department of Energy's Kansas City Plant (Missouri) to provide ordnance designers with the tools to address the initiation system element of these requirements. One tool undergoing development is the Adaptable Miniature Initiation System Technology (AMIST)—a multipoint system designed for initiating explosive warheads. A key goal of the AMIST program effort is to ensure the developed system incorporates highly accurate and precise timing between fire points. Precision multipoint initiation allows the warhead designer to develop a weapon for which the detonation front is directly controllable via the initiation sequence

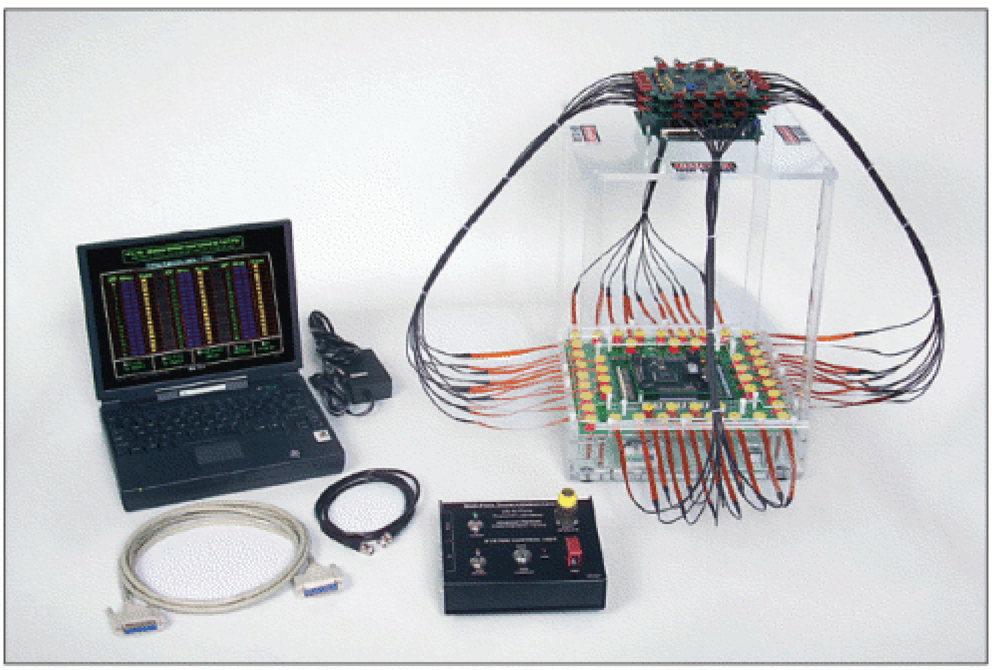

Figure 1. AMIST Configuration I with centrally controlled fire points

of fire points within the explosive fill. The resulting warhead can bias the directional path of its fragments and thus increase the energy focused towards the selected target. Not only does AMIST have enormous potential to meet the demands for future dual-role munitions, it is also a very reliable and safe initiation system. Each fire point utilizes an exploding foil initiator (EFI) to detonate an insensitive secondary explosive. The in-line (no moving parts) nature of EFIs increases their reliability over out-of-line initiation systems.

Likewise, EFI fire points increase the safety factor for two main reasons: (1) firing an EFI requires a very high-voltage pulse with a specific shape, and (2) detonating the secondary explosive requires a very high-pressure shock. Consequently, inadvertent detonation is extremely unlikely. In July 2004, AFRL researchers conducted AMIST Configuration I(see Figure 1 on previous page)proof-of-concept tests at the Advanced Warhead Experimentation Facility (AWEF),(Eglin Air Force Base, Florida)to prove that a multipoint initiation system comprising relatively inexpensive initiators could successfully operate in an explosive fill with precision timing. The test article consisted of a planar array of AMIST-controlled fire points located on the backside of a high-explosive disc. Researchers performed the tests using both simultaneous fire point detonation and individual, temporally distributed fire point detonations. Using streak and high-speed cameras, they recorded the detonation breakout on the front surface of the disc to verify the two distinct initiation sequences. Approximately a year later, the team used AMIST Configuration I to support Fuel Air Explosive (FAE) testing at the AWEF. The goal of these tests was to determine the feasibility of directing an explosive blast within an FAE cloud via strategic placement and detonation of multiple initiators. The test setup consisted of an enclosed configuration of FAEs with several fire points arranged on the outer surface of the enclosure. Researchers recorded the test events with high-speed video cameras and pressure sensors. The tests proved the viability of detonating an FAE cloud using a multipoint initiation system.

Figure 2. AMIST Configuration II with autonomous fire point control following fire command and controller disconnect

The current system architecture, AMIST Configuration II, facilitates the programming of multiple fire points capable of operating autonomously upon disconnecting from the controller. The programming can direct the fire points either to fire simultaneously or to fire individually, delayed with negligible timing errors. AMIST Configuration II (see Figure 2) is the first multipoint initiation system to combine high timing precision with fire point autonomy. Each fire point consists of a logic board with processing and memory capabilities, a firing capacitor, and a high-voltage switch. A centralized controller uses a data bus to communicate with the fire points to update the firing modes at rapid intervals. Warhead designers pre-program a set of firing modes into the multipoint system, and each mode produces a different warhead effect. Based on the location of a given target relative to the warhead, the centralized controller selects the firing mode that will generate optimal lethality. Upon receiving the fire command, each firepoint can disconnect from the data bus without affecting its operational performance. At the point of disconnect, the fire point no longer receives firing mode updates from the controller.

Instead, it operates autonomously, using its own internal processor and memory to detonate at the time corresponding to the designated firing mode. Testing has confirmed AMIST as a precise and reliable means of achieving multipoint initiation for future weapon systems. Although researchers developed the technology for potential transition to a dual-role weapon system, it has also proven useful as a range asset for other types of tests requiring controlled detonation of multiple firepoints. AMIST has thus established itself as ideal for integration with any weapon system requiring a high level of lethality and a decreased probability of extensive collateral damage.

Capt Kenneth C. Bradley, Mr. Ed Wild, and Lt Chris Martin, of the Air Force Research Laboratory's Munitions Directorate, and Lt Roger Platteborze, of the Air Armament Center, wrote this article. For more information, contact TECH CONNECT at (800) 203-6451 or place a request at http://www.afrl.af.mil/techconn_index.asp. Reference document MN-H-06-03.